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Perceptual Asymmetry Differences Between Major Depression With or Without a Comorbid Anxiety Disorder: A Dichotic Listening Study

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Predictions that anxious and nonanxious depression would differ in perceptual asymmetry (PA), as well as in sensitivity for perceiving emotional words, were evaluated using dichotic listening tasks. A total of 149 patients having a major depressive disorder (51 with and 98 without an anxiety disorder) and 57 healthy controls were tested on fused-word and complex tone tasks. The anxious and nonanxious depression groups showed a consistent difference in PA across tasks; that is, the anxious group had a larger left-ear advantage for tones and a smaller right-ear advantage for words when compared with the nonanxious group. There was no group difference in sensitivity for perceiving emotional words. Patients having an anxious depression appear to have a greater propensity to activate right than left-hemisphere regions during auditory tasks, whereas those having a nonanxious depression have the opposite hemispheric asymmetry.

About half of patients having a major depressive disorder (MDD) exhibit comorbidity with an anxiety disorder (e.g., Gulley & Nemeroff, 1993; Maser & Cloninger, 1990). Although the clinical differences between patients having an anxious MDD and those having a "pure" MDD without an anxiety disorder have been extensively investigated (e.g., Grunhaus, Pande, Brown, & Greden, 1994), less is known concerning the neurocognitive differences between these forms of depressive illness. It has also been suggested that failure to take comorbidity of depression and anxiety into account may be responsible for conflicting findings concerning right parietal hypoactivation in depression (Heller, Etienne, & Miller, 1995).

The possibility that anxious MDD and nonanxious MDD may differ in their right–left brain function is suggested by evidence that depression and anxiety are associated with very different abnormalities of lateralized cognitive processing. Findings of reduced left-hemifield advantages for nonverbal processing in depressed patients have supported the hypothesis that cognitive abnormalities in depression are related to right-hemisphere dysfunction (Bruder et al., 1989; Heller et al., 1995; Jaeger, Borod, & Peselow, 1987; Miller, Fujioka, Chapman, & Chapman, 1995). In contrast, studies have found evidence of left-hemisphere dysfunction or right-hemisphere hyperactivation in students with high trait anxiety (Heller et al., 1995; Tucker, 1981) or patients with anxiety disorders (Liotti, Sava, Rizzolatti, & Caffarra, 1991). Heller et al. (1995) hypothesized that anxious arousal, such as seen in panic disorder or social phobia, is associated with high right parietotemporal activation, whereas "pure" depression is associated with reduced right parietotemporal activity. Using hemispatial bias for perceiving chimeric faces as a measure of characteristic asymmetry of hemispheric activation, they found that students with high levels of trait anxiety had a large left hemifield (right hemisphere) bias, whereas students with high levels of depression had a small left hemifield (right hemisphere) bias.

A recent quantitative electroencephalographic (EEG) study found that patients with comorbidity of MDD and an anxiety disorder had the opposite alpha asymmetry pattern at posterior sites when compared with MDD without an anxiety disorder (Bruder et al., 1997). Patients having an anxious MDD showed evidence of greater activation over right than left posterior sites, whereas patients having a nonanxious MDD had less activation over right than left posterior sites. Given that asymmetry of resting EEG at posterior sites is likely to be related to lateralized performance on perceptual tasks (Davidson, Chapman, Chapman, & Henriques, 1990; Davidson & Hugdahl, 1996), one would predict that anxious and nonanxious MDD would

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also differ in perceptual asymmetry (PA) on dichotic listening or other behavioral laterality tasks.

Levy, Heller, Banich, and Burton (1983) presented evidence that a large proportion of the variation in PA among individuals arises from individual differences in characteristic asymmetry of hemispheric activation, which are stable and task-independent. If the opposite pattern of posterior alpha asymmetry in anxious and nonanxious MDD reflects a difference in characteristic hemispheric activation, these subgroups should show a consistent asymmetry difference across verbal and nonverbal dichotic listening tasks. Given a bias favoring right-hemisphere activation in anxious MDD and left-hemisphere activation in nonanxious MDD, anxious MDD patients would be predicted to show a larger left-ear (right-hemisphere) advantage for complex tones, but a smaller right-ear (left-hemisphere) advantage for words when compared with depressed patients without an anxiety disorder. This prediction was evaluated using PA scores for dichotic word and complex tone tasks and, most importantly, using a measure of "characteristic PA" that combines asymmetry scores across these verbal and nonverbal tasks, thereby providing a task-independent index of hemifield bias. Moreover, given the predominance of contralateral projections from the ear to auditory cortex, absolute accuracy scores for the complex tone task provided additional information concerning the possible source of relative asymmetry differences between groups. Specifically, if patients with an anxious MDD have enhanced right-hemisphere activation, they might be expected to show better left-ear accuracy for complex tones when compared with controls. In contrast, if patients with a nonanxious MDD have reduced right-hemisphere activation, they should show poorer left-ear accuracy for complex tones when compared with controls.

The patients in this collaborative study were also tested on a dichotic task with emotion-evoking words. In negative–neutral dichotic pairs, an emotionally neutral word (*till*) is presented to one ear, and a word evoking negative feeling (*kill*) is simultaneously presented to the other ear. The word pairs fuse to form a single percept and participants sometimes report hearing the neutral word from the stimulus pair, while at other times they hear the negative word. An emotional proclivity index (EPI) gives a measure of the proportion of trials on which the negative word is the one heard. Wexler, Levenson, Warrenburg, and Price (1994) found that patients having an MDD (without a comorbid anxiety disorder) had a reduced EPI to both negative and positive words. Because the right hemisphere plays a specialized role in processing emotional stimuli (Bryden & MacRae, 1989; Sackeim, 1991), this hyposensitivity to emotional words can be seen as consistent with other evidence of right-hemisphere dysfunction in a subgroup of depressed patients. If, on the other hand, depressed patients with a comorbid anxiety disorder have heightened right posterior activation due to anxious arousal, this would predict a greater EPI to negative words in anxious MDD when compared with depressed patients without an anxiety disorder. A further purpose of our study was to test this prediction.

Method

Participants

Depressed patients were recruited from a Depression Evaluation Service at New York State Psychiatric Institute (NYSPI) and from the Connecticut Mental Health Center (CMHC). A total of 149 patients (NYSPI, $n = 90$; CMHC, $n = 59$) were tested on both the verbal and nonverbal dichotic tasks. All aspects of the diagnostic assessment of the patients were carried out by research psychiatrists at these clinics. Patients met *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., *DSM–IV;* American Psychiatric Association, 1994) criteria for MDD as determined by an initial semistructured diagnostic interview and by repeated assessments aimed at confirming the initial *DSM–IV* diagnoses. Fifty-one patients also met *DSM–IV* criteria for one or more of the following anxiety disorders and are referred to as the anxious MDD subgroup: social phobia ($n = 27$), panic disorder ($n = 19$), generalized anxiety disorder ($n = 4$), or obsessive–compulsive disorder ($n = 6$).[1] The remaining 98 patients did not meet criteria for an anxiety disorder and are referred to as the nonanxious MDD subgroup. Only 2 patients in each subgroup met *DSM–IV* criteria for melancholia. A total of 57 healthy controls were recruited from hospital staff, colleges, and communities surrounding NYSPI ($n = 31$) and CMHC ($n = 26$). Controls were screened using a modified version of the Schedule for Affective Disorders and Schizophrenia—Lifetime Version (Spitzer & Endicott, 1975) to exclude those with current or past psychopathology. Participants were excluded from the study if they had a hearing loss greater than 30 dB in either ear at 500, 1,000 or 2,000 Hz or if they had an ear difference greater than 10 dB. Participants were also excluded if they had current substance abuse or a history of head trauma or other neurological disorder. Table 1 gives the characteristics of the anxious-depression, nonanxious-depression, and control groups. The anxious- and nonanxious-depression groups did not differ significantly in gender, age, education, or handedness. The anxious depressives ranged in age from 20 to 58 years, the nonanxious depressives from 20 to 65 years, and the controls from 20 to 62 years. There was a small but statistically significant difference in mean age among groups, $F(2, 203) = 5.47$, $p < .05$. Multiple comparison tests indicated that the controls were younger than the nonanxious depressives ($p < .05$), but there were no other significant differences in age among groups. There was also a difference among groups in education, $F(2, 195) = 5.99$, $p < .01$, with the controls having on the average about 1 year more education than the patient groups. There was no difference among groups in handedness laterality quotients (LQs) on the Edinburgh Handedness Inventory (Oldfield, 1971). An LQ score of 100 indicates complete right-hand preference and −100 indicates complete left-hand preference. Four anxious depressives, 7 nonanxious depressives, and 5 controls were left-handed; the remaining patients and controls were right-handed.

Mean scores on the Beck Depression Inventory (Beck, Ward, Mendelson, & Erbaugh, 1961) were the same for the anxious- and nonanxious-depression groups (see Table 1) but were significantly lower for controls, $F(2, 198) = 139.38$, $p < .001$. There were significant differences among groups in trait anxiety scores on the State–Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), $F(2, 196) = 189.29$, $p < .001$. Multiple comparisons indicated that the anxious depressives had significantly higher trait anxiety scores than nonanxious depressives, and controls had lower scores than either patient group ($p < .05$).

Procedure

Patients were tested after a minimum drug-free period of 10 days. Each participant was tested on the dichotic fused-words and complex tone tests, with the order of these tests being counterbalanced across patients and controls. All but 9 of the patients were also tested on the emotional

[1] A question may be raised as to the appropriateness of combining patients with various types of anxiety disorders. Although sample sizes for two of the anxiety disorders were too small to separately examine them, an analysis of variance (ANOVA) of the PA scores for patients having social phobia (without panic; $n = 22$) versus patients having a panic disorder (without social phobia; $n = 14$) did not reveal any difference in PA between these groups, $F(1, 34) < 1.0$, $p > .50$.

Table 1
Participant Characteristics

Characteristic	Nonanxious MDD	Anxious MDD	Controls
Gender			
Women	54	31	33
Men	44	20	24
Age (years)			
M	40.5	37.6	35.4[a]
SD	10.6	9.8	10.5
Education (years)			
M	14.9[b]	14.3[c]	15.8[d]
SD	2.3	2.5	2.2
Handedness (LQ)			
M	75.1	75.2	75.8
SD	42.8	45.2	47.0
Beck Depression Inventory			
M	23.0[e]	22.9	2.3[d,f]
SD	9.1	8.4	3.2
Trait Anxiety Scale			
M	76.1[g]	79.9[h,i]	46.9[d]
SD	11.2	8.2	9.1

Note. MDD = major depressive disorder. LQ = laterality quotient. [a] Controls differ significantly from nonanxious MDD, $p < .05$. [b] $n = 91$. [c] $n = 50$. [d] Controls differ significantly from anxious MDD and nonanxious MDD, $p < .05$. [e] $n = 96$. [f] $n = 54$. [g] $n = 95$. [h] Anxious MDD and nonanxious MDD differ significantly, $p < .05$. [i] $n = 47$.

fused-words task. Although each task is described in detail in prior reports, a brief description of each is given below.

Fused-words task. The Fused Rhymed Words Test (Wexler & Halwes, 1983) consists of 15 different single-syllable word pairs in which each member of every pair differs from the other only in the initial consonant (e.g., *coat, goat*). All words begin with one of six stop consonants (*b, d, p, t, g, k*) and are natural-speech spoken by a male voice. When presented dichotically, the members of each pair fuse into a single percept. Participants indicate what word they heard by marking a line through it on a prepared answer sheet that has four possible responses, both members of the dichotic pair and two other words differing from the dichotic stimuli only in the initial consonant. Following practice trials, each participant received four 30-item blocks for a total of 120 trials. Orientation of headphones was reversed after the first and third quarters to control for channel differences and ear of presentation. The words were presented via a matched pair of TDH-49 headphones (Telephonics Corp., Huntington, NY) at a comfortable level of 75 dB sound pressure level (SPL).

Complex tone task. The Complex Tone Test (Sidtis, 1981) requires participants to compare the pitch of a binaural complex tone to the pitches of a dichotic pair of complex tones presented 1 s earlier. Participants point to a response card labeled "YES" when the probe tone is the same as either member of the previous dichotic pair or to a card labeled "NO" when it differs from both. The complex tones are square waves with fundamental frequencies corresponding to eight notes in the octave between C4 and C5. After 16 binaural and 16 dichotic practice trials, participants were tested on four blocks of 28 trials in which half of the probe tones matched a member of the dichotic pair and half did not. Orientation of headphones was reversed after the first two blocks. The tones were presented at 72 dB SPL.

Emotional words task. This test is similar in construction to the Fused Rhymed Words Test, except that one word in each dichotic pair was previously rated as being associated with negative feelings and the other word was rated as being neutral (see Wexler, Schwartz, Warrenburg, Servis, & Tarlatzis, 1986, for a list of the word pairs and other details). Words in each pair differed from one another only in their initial consonants (e.g., *bad, pad*). The high degree of auditory spectral overlap between the words in a pair and their precise temporal alignment causes them to fuse into a single percept. As in the other word task, participants indicate the word they heard using a four-alternative answer sheet. The test consists of 11 different stimulus pairs and contains a total of 88 trials. In other respects, test administration was the same as for the Fused Rhymed Words Test.

Data Analyses

The number of correct responses was computed for right (R) and left (L) ear presentations in the dichotic word and complex tone tasks. These accuracy scores were used to compute a measure of perceptual asymmetry (PA) for each task, that is, PA = 100(R–L)/(R+L). A 3 × 2 × 2 analysis of variance (ANOVA) of PA scores included the variables of group (anxious MDD, nonanxious MDD, and controls), site (NYSPI and CMHC), and a repeated measure factor task (fused words and complex tones). A measure of characteristic PA was also computed by averaging the standardized PA scores on the dichotic word and complex tone tasks. The standardized PA for each task was computed by subtracting the score for each participant from the mean for all participants and dividing this by the standard deviation of scores. An ANOVA of the characteristic PA scores and Newman–Keuls multiple comparison tests were used to test the significance of group differences.

A 3 × 2 × 2 ANOVA was performed on the absolute accuracy scores for the complex tone task, with the variables being group, site, and ear. This analysis was not possible on the data for the fused-words task because accuracy was essentially 100% correct for the single response given on each trial.

The emotional words task yielded both a measure of PA and a measure of how often participants heard the emotion-evoking word as compared with the neutral word, that is, an emotional proclivity index (EPI). An EPI score was computed by subtracting the number of neutral words heard from the number of negative words heard, dividing the difference by the sum of the two, and multiplying by 100. A 3 × 2 ANOVA was used to evaluate group and site differences on the PA and EPI measures.

Pearson correlation coefficients examined the relation between ear advantages (PA scores) for each task and scores on the Beck Depression Inventory and the State–Trait Anxiety Inventory. Correlations were also computed between PA scores and age, education, and handedness LQ of participants. These correlations were separately performed for patients (pooled across anxious and nonanxious groups) and controls. Given significant correlations for patients, separate analyses examined relations within the anxious and nonanxious patient groups.

Results

Perceptual Asymmetry

Figure 1 gives the mean PA scores for the nonanxious-depressive, anxious-depressive, and control groups on the dichotic fused-word and complex tone tasks. There was a marked difference in ear advantages across tasks, which was confirmed by an ANOVA of the PA scores, $F(1, 200) = 106.22$, $p < .001$. As expected, there was a right-ear (left-hemisphere) advantage on the fused-words task and a left-ear (right-hemisphere) advantage on the complex tone task. The ANOVA also revealed a significant difference in ear advantages among groups, $F(2, 200) = 6.78$, $p = .001$, which was not dependent on task; that is, there was no Group × Task interaction, $F(2, 200) = 1.60$, $p = .20$.[2] The only

[2] An ANOVA of the PA scores for only right-handed participants in each group yielded the same results as for the total samples. Namely, there were significant differences in PA between tasks, $F(1, 184) = 104.43$, $p < .001$, and among groups, $F(2, 184) = 5.73$, $p = .004$.

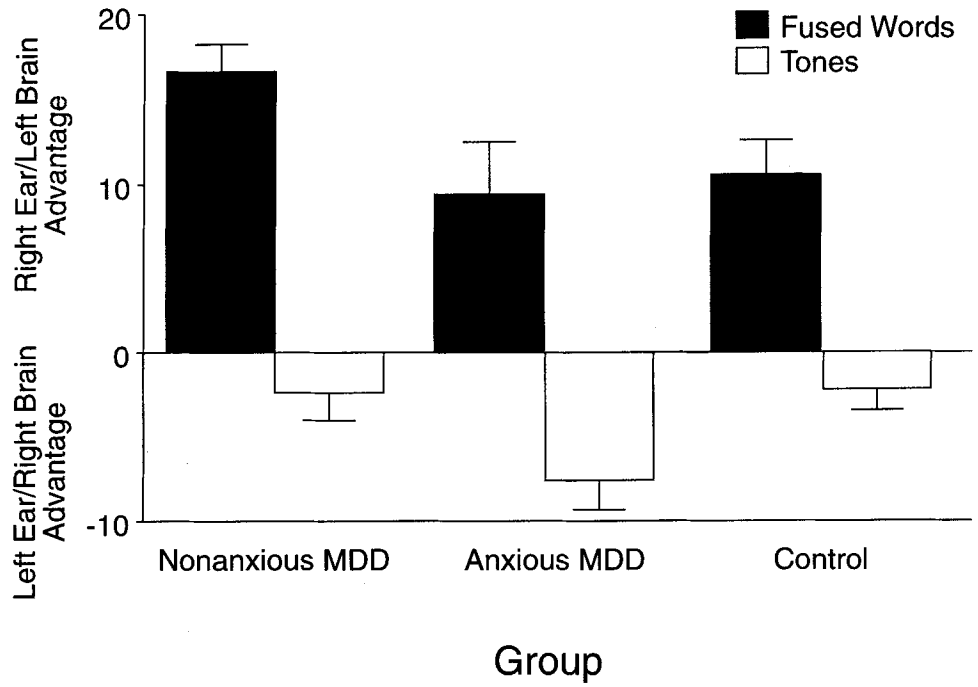

Figure 1. Means and standard errors of perceptual asymmetry (PA) scores on fused words and complex tone tasks for nonanxious depressive, anxious depressive, and healthy control groups. MDD = major depressive disorder.

significant interaction was between group and site, $F(2, 200) = 3.43$, $p < .05$. The previously mentioned differences in ear advantages among groups were in the same direction at each site but tended to be larger at the CMHC site.

As can be seen in Figure 1, the difference in PA between the anxious and nonanxious MDD groups was in the predicted direction on both tasks, that is, larger left-ear advantage for tones but smaller right-ear advantage for words in the anxious MDD group, and was about equal in magnitude across tasks. This consistent difference in ear advantages between groups was further examined using a characteristic PA index that combines the asymmetry scores for the verbal and nonverbal tasks and thereby provides a task-independent index of hemifield bias. The characteristic PA scores showed that the anxious MDD group had a bias favoring the left ear ($M = -.24$, $SD = .79$), the nonanxious MDD group had a bias favoring the right ear ($M = .14$, $SD = .85$), and controls showed essentially no bias ($M = -.02$, $SD = .55$). An ANOVA confirmed the difference in characteristic PA scores among groups, $F(2, 203) = 4.22$, $p < .025$, and multiple comparisons indicated that the scores for anxious and nonanxious groups were significantly different ($p < .05$), but controls did not differ significantly from either group.

Accuracy Scores for Complex Tones

Figure 2 gives the accuracy scores for each group on the complex tone task. An ANOVA of these scores revealed a significant ear effect reflecting the greater accuracy for left- than right-ear tones, $F(1, 200) = 27.93$, $p < .001$. There was also a Group × Ear interaction confirming the difference in left-ear (right-hemisphere) advantage among groups, $F(2, 200) = 3.95$, $p < .05$.[3] As can be seen in Figure 2, the larger left-ear (right-hemisphere) advantage of the anxious MDD group, when compared with the other groups, was due not to their better left-ear accuracy but rather to their poorer right-ear accuracy. The group difference in right-ear accuracy approached significance, $F(2, 203) = 2.54$, $p = .08$, whereas there was clearly no difference in left-ear accuracy among groups, $F(2, 203) = 1.01$, $p = .37$. It should also be noted that there was no Group × Ear × Site interaction, confirming that the group difference in left-ear (right-hemisphere) advantage for complex tones was comparable across sites.

Emotional Words Task

The PA scores for the emotional words task revealed the same group difference in right-ear advantage as seen for the fused-words task, $F(2, 191) = 4.93$, $p < .01$. Table 2 shows that the nonanxious MDD group had almost twice as large a right-ear (left-hemisphere) advantage as compared with the other two groups. Multiple comparison tests confirmed that the right-ear (left-hemisphere) advantage for the nonanxious MDD group was significantly greater when compared with either the anxious MDD or control groups ($p < .05$). This group difference was equally present at each site.

Table 2 also gives the mean EPI scores for the groups. The positive EPI score seen for the anxious MDD group is indicative of

[3] An ANOVA of accuracy scores on the complex tone task for only right-handed participants yielded the same results as seen for the total samples. There was a significant ear effect, $F(1, 184) = 26.50$, $p < .001$, and a Group × Ear interaction, $F(2, 184) = 3.31$, $p < .05$.

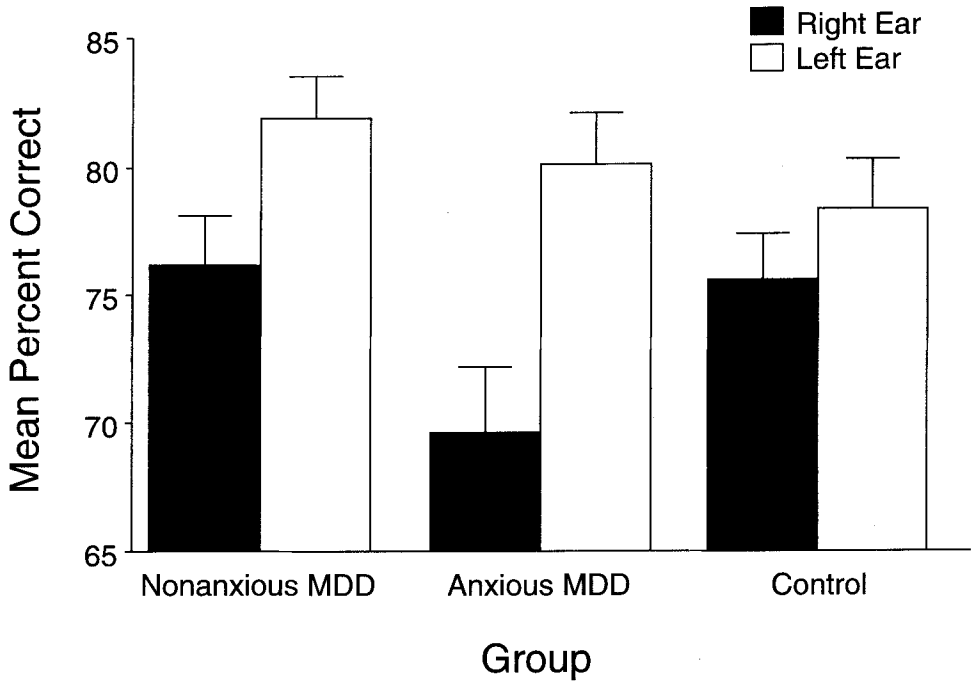

Figure 2. Means and standard errors of accuracy scores for complex tones presented to the right or left ear for nonanxious depressive, anxious depressive, and healthy control groups. MDD = major depressive disorder.

greater perception of emotion-evoking words than neutral words, whereas the negative score seen for the other groups indicates the opposite preference. There was, however, no significant difference in EPI scores among groups, $F(2, 191) = 1.40$, $p = .25$.

Correlational Analyses

No significant correlations were found between ear advantages (PA scores) for patients and scores on the Beck Depression Inventory and State–Trait Anxiety Inventory ($r = -.06$ to $r = .03$). Interestingly, higher trait anxiety scores within the control group were associated with smaller right-ear (left-hemisphere) advantage for the fused-words task ($r = -.31$, $p < .05$). Correlational analyses also examined the relation of ear advantages and age, education, and handedness LQ. The only significant correlation was between age of patients and right-ear advantage for fused words ($r = .18$, $p < .05$). Separate analyses within each patient subgroup revealed that this correlation was present within the nonanxious ($r = .26$, $p < .05$) but not the anxious subgroup ($r = -.003$). Thus, older nonanxious depressed patients were particularly likely to show heightened right-ear (left-hemisphere) advantage for words. The relatively weak relationship between age and ear advantage for words in the nonanxious subgroup could not account for the differences in PA between the anxious and nonanxious groups because these groups did not differ in age. Also, there was no significant correlation between age and ear advantage for words ($r = -.12$) or tones ($r = -.02$) among healthy controls.

Table 2
Performance on the Emotional Words Task

Measure	MDD patients: Nonanxious (n = 92)	MDD patients: Anxious (n = 48)	Controls (n = 57)
Perceptual asymmetry			
M	12.3[a]	6.5	7.4
SD	13.5	12.5	12.6
Emotional proclivity index			
M	−3.2	4.7	−3.1
SD	29.4	30.1	29.3

Note. MDD = major depressive disorder.
[a] Nonanxious MDD differs significantly from anxious MDD and healthy controls, $p < .05$.

Discussion

About one third of patients having an MDD at two research clinics also had an anxiety disorder. This is consistent with the high rate of comorbidity of depressive and anxiety disorders (Maser & Cloninger, 1990). *DSM–IV* criteria for the presence of anxiety disorders were effective in separating depressed patients into anxious and nonanxious subgroups with different PA on dichotic listening tasks. The consistent direction and magnitude of the PA difference between these subgroups on the verbal and nonverbal tasks support the hypothesis that anxious and nonanxious MDDs differ in their characteristic pattern of hemispheric activation. Thus, despite the different cognitive demands and direction of hemispheric dominance for the complex tone and word tasks, the anxious and nonanxious subgroups showed a consistent, task-independent difference in hemifield bias. An index of characteristic PA, which combines PA scores for the verbal and nonverbal tasks, indicated that the anxious MDD group had a bias

favoring the left ear (right hemisphere), whereas the nonanxious MDD group had an opposite bias favoring the right ear (left hemisphere).

In a prior study (Bruder et al., 1996), characteristic PA was able to differentiate depressed patients into two subgroups with different response rates to the antidepressant fluoxetine (Prozac). Interestingly, the "pure" depressive group in the present study had a characteristic PA that resembles that seen for fluoxetine responders, whereas the comorbid depressive group had a characteristic PA that resembles that seen for fluoxetine nonresponders. Fava et al. (1997) investigated relationships between depressive subtypes and response to fluoxetine. MDD with comorbid anxiety disorder was the only subtype significantly associated with poorer response to fluoxetine. This suggests the existence of a subtype of major depression characterized by a comorbid anxiety disorder, a relative favoring of right- over left-hemisphere activation, and poorer outcome of treatment with antidepressants. Despite the diagnostic and PA differences between anxious and nonanxious MDD, the difference in State–Trait Anxiety Inventory scores between these groups was relatively small. This is likely to reflect the lack of specificity of these self-reports for assessing anxiety as opposed to depression (Clark & Watson, 1991).

The direction of the difference in characteristic PA between anxious and nonanxious MDD agrees with EEG alpha asymmetry findings indicative of relatively greater right than left posterior activation in anxious depression, but greater left than right posterior activation in nonanxious depression (Bruder et al., 1997). A favoring of right over left posterior activation in anxious depression could stem from hyperactivation of right parietotemporal regions due to anxious arousal (Heller et al., 1995), from hypoactivation of the left-hemisphere regions, or from some combination of both. Heller, Nitschke, Etienne, and Miller (1997) reviewed neuroimaging and behavioral laterality findings supporting the existence of greater right- than left-hemisphere activation in patients having panic disorders and in high-anxious participants. Evidence of left-hemisphere hypofunction in anxiety has come from findings of poor right visual field (left hemisphere) performance on cognitive tasks in participants with high trait anxiety (Tucker, 1981) or in patients with a generalized anxiety disorder (Liotti et al., 1991). In the present study, the enhanced left-ear advantage for pitch discrimination in anxious depression was not due to better left-ear accuracy but to poorer right-ear accuracy. Given the predominantly contralateral nature of projections from ear to auditory cortex, this finding is more suggestive of left-hemisphere hypofunction in anxious depression. It is, however, also possible that anxious arousal not only activates the right hemisphere but also facilitates callosal transfer of the left-ear input, and therefore, the reduction of right-ear accuracy could be due to increased left-ear stimulus interference of the right-ear stimulus (Asbjörnsen, Hugdahl, & Bryden, 1992). This mechanism could also account for findings of reduced right-ear advantage for dichotic words or syllables in high-anxious, nondepressed adults (Asbjörnsen et al., 1992; Wexler et al., 1986).

Nonanxious depressed patients had a larger right-ear advantage than anxious depressed patients or normal controls on both the Fused Rhymed Words Test and the emotional words test. This is suggestive of a relative favoring of left over right parietotemporal activation in "pure" major depression, which is consistent with the direction of EEG alpha asymmetry for depressed patients at posterior sites (Bruder et al., 1997; Davidson, Schaffer, & Saron, 1985; Henriques & Davidson, 1990). EEG and imaging studies indicate that dichotic listening is likely to involve perceptual processes in posterior temporal and parietal regions (Coffey, Bryden, Schroering, Wilson, & Mathew, 1989; Davidson & Hugdahl, 1996). Increased right-ear advantage for dichotic words is also seen in neurological patients with right temporal lobe lesions (e.g., Kimura, 1961; Schulhoff & Goodglass, 1969). The nonanxious depressed patients did not, however, differ from controls in their asymmetry or accuracy for dichotic complex tones, which provides no support for a right-hemisphere hypoactivation interpretation of their difference in PA for words. Studies using more direct measures of regional hemispheric activation during dichotic listening (e.g., event-related potential or neuroimaging measures) are needed to determine the basis for both the enhanced right-ear advantage for words in "pure" depression and the enhanced left-ear advantage for pitch discrimination in anxious depression.

Last, there was no significant difference among groups in sensitivity for perceiving emotion-evoking words. Inspection of the data for the emotional words test (see Table 2) suggests that this may have been due to the large variance of EPI scores among participants. The difference in EPI scores between the anxious and nonanxious patients was in the predicted direction (i.e., greater sensitivity to negative words in anxious patients), and was about equal in magnitude to the difference in right-ear advantage between these groups. The standard deviation of EPI scores was, however, considerably larger than that for PA scores, resulting in a smaller effect size that was too weak to demonstrate even with the relatively large samples in this study. Studies using measures of autonomic responsivity to emotional stimuli (e.g., electrodermal activity or facial electromyography) and more direct measures of regional hemispheric activation to emotional stimuli (e.g., Heller et al., 1997; Kayser et al., 1997) may help better characterize differences in emotional responsivity between anxious and nonanxious depression.

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